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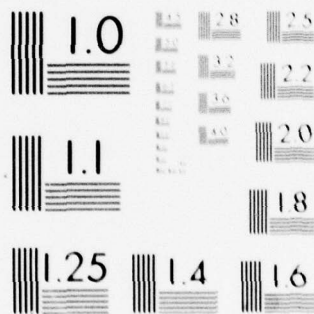
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(6) ELECTRONICS RESEARCH IN THE ARMY .

(11) February 1979

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PREFACE

The purpose of this document is to describe in a fairly brief way the Army's on-going program of research in the area of electronics. The term "research" in the Army has over the past years been interpreted in a variety of ways. For the understanding of this document the operating definition and the role of research in the Army is quoted from the National Science Board 1978 documentation on "Basic Research in the Mission Agencies."

"In furtherance of its mission, the Army supports an extensive research program including basic research. Although the Army does not specifically define "basic research," the operating definition for "research" is:

.scientific study and experimentation directed toward: increasing knowledge and understanding in those fields of the physical, engineering, environmental and life sciences related to long-term national security needs; providing fundamental knowledge required for the solution of military problems; and forming a part of the base for (a) subsequent exploratory and advanced developments in Defense-related technologies and (b) new or improved military functional capabilities in areas such as communications, detection, tracking, surveillance, propulsion, mobility, guidance and control, navigation, energy conversion, materials and structures, and personnel support.

The Army's policy concerning support of research is to:

- Maintain a strong and progressive research base by conducting a broad and continuing research program, including an adequate in-house capability, to provide fundamental knowledge with emphasis on those areas of special promise to the Army.
- Encourage and ensure investigation of new ideas and concepts that may contribute to the Army mission and/or reduce the cost of maintaining and operating Army systems and equipment.
- Encourage multiservice support of those facets of research that will affect the developments programs of more than one military service.
- Support and conduct research in the fields of training and education for the broad purpose of reducing training time and costs and increasing training effectiveness.

- Maintain effective contact between the Department of the Army and scientists of the United States and, when appropriate, other nations of the free world."

This document is directed to those persons who have an interest in the Army's current and long term goals for research in electronics. Concise descriptions are given for each of the major areas of the current programs and an attempt is made to predict future research requirements. Since many laboratories within the Army are involved in this program, a listing of those U. S. Army Materiel Development and Readiness Command installations which have a significant program in the field of electronics and communication sciences may be found starting on page 14. Persons having a specific interest in one of the areas should contact the appropriate laboratory or agency directly; addresses are given.

It is appropriate to acknowledge that this document was compiled and coordinated by members of the ad hoc Army Research Office Electronics Division Advisory Panel consisting of representatives from Harry Diamond Laboratories, Electronics Technology and Devices Laboratory, Night Vision and Electro-Optics Laboratory, Communications Research and Development Command, Missile Research and Development Command, and White Sands Missile Range. The ARO Electronics Division thanks the panel members for the time and effort spent in the preparation of this document.

JIMMIE R. SUTTLE
Director
Electronics Division
US Army Research Office

ARMY ELECTRONICS PROGRAM

I. INTRODUCTION

In the past, the ability to win wars was based on motivation and industry's ability to respond to needs. The contributions that science and technology have made to the military have so drastically reduced the time during which a nation can respond that victory now depends on technological preparedness. The duration of war can no longer be thought of in terms of years, but of weeks or months; the fact that modern warfare would allow little time to learn and respond was demonstrated by the Mideast wars. The pace of modern war would be so rapid that commanders would have little time to gather the information on which to base decisions. The availability of reliable and sophisticated electronic systems to provide the commanders with real-time information on which to base decisions could make the difference between victory and defeat.

During the last decade, the electronics industry has been operating in an increasingly competitive, inflationary, worldwide market; every available resource has been dedicated to maintaining profit margins. In this environment, industry has been forced to curtail advanced research in favor of the more immediate goals of production and profit. Attention has been almost wholly shifted to commercial/consumer products.

This commercial orientation serves some of DoD's interests, but many other military needs are not being met. The Army must be aware of relevant industrial effort and at the same time fill those research gaps where commercial motivation does not exist. Toward this end, application-oriented basic research is performed in Army laboratories as well as on a contractual basis with universities and selected non-profit and industrial laboratories. The Army's efforts in electronics and communications sciences contribute to establishing and maintaining a science and technology base through the exploration of novel phenomena and the generation of new concepts relevant to the Army's needs in electronics technology. The objective is to provide a base in selected areas of physics, electronics, communications, and computer engineering to help satisfy present and future Army requirements. Fundamental research is performed on signal generation, transmission, reception and processing; computer systems and communication theory; solid-state electronics, including semiconductors, superconductors, magnetics, and dielectrics; and circuitry and networks. Army electronics research applies to a wide variety of problems in communi-

cation, command, and control; surveillance and target acquisition; ballistic missile and air defense; and fire support and electronic warfare.

II. PROGRAM OBJECTIVES

Various considerations lie behind the specific requirements for military electronics. Military electronics has a high-priority need for high-speed devices and systems. Some military systems process extremely large quantities of data such as those in maps and images; these data must be processed with great speed so that systems can react to threats in real time.

All military electronic systems must be highly reliable and readily available. When a commercial system fails, the result is not catastrophic; the user can wait until the system is repaired. Military activities cannot afford this luxury. Electronic warfare requirements have expanded tremendously; therefore, military electronic systems must be resistant to interference and interception. They must be able to operate in hostile environments, both those imposed by opposing forces and those due to the locations of the equipment.

Because military systems rely heavily on electromagnetic propagation, we must understand the components and the propagation characteristics of microwave, millimeter-wave, and electro-optics systems. Military systems must detect and identify noncooperative targets, must intercept and diagnose signals, and may perform many distributed interdependent functions.

Substantial improvements in mobility is another major requirement of military electronic systems. Electronic equipment must be small and lightweight and capable of rapid emplacement, tear-down and movement.

Finally, military electronic systems must be maintained in the field, often by personnel who have not had many years of training and experience in handling these systems. As a consequence, the systems must be easy to repair and must do a fair amount of self-diagnosis and maintenance.

What requirements do these considerations place on Army electronics research? We must emphasize high-speed signal-processing devices, materials, and techniques. We must have the technology to process large amounts of information rapidly and reliably. We must also thoroughly understand those

processes which affect device, circuit and system reliability. We must understand and control the propagation and scattering of electro-magnetic radiation. We must explore improvements in and invent new microwave, millimeter-wave, and electro-optical devices and materials. We need to thoroughly understand the theory of complex distributed nonlinear electronic systems. Areas of prime concern include the physics of surfaces, interfaces, and fabrication processes for semiconductor devices, as well as circuit and system reliability, testability, and fault analysis and prediction.

III. TECHNICAL PROGRAM DESCRIPTION

Outlined below are summaries of subtasks of current Army activities that emphasize fundamental research. The listing begins with the physics of the performance of components and culminates in the description of large, interrelated systems. While not implying any priorities, the list highlights areas of research which broadly bear upon the science and technology base of Army electronics. However, it must be noted that this description by its very nature cannot be all-encompassing.

A. Solid-State Electronics

1. Semiconductors

An important Army objective in the study of semiconductors is to advance materials technology aimed at novel or improved electronic devices. The Army's primary activities and main interests extend to basic studies on new methods for electronic material synthesis, controlled doping (concentration and geometry), and electrical as well as metallurgical characterization. Research targets are bulk and thin-film GaAs, InP, HgCdTe, and high-merit ternary and quaternary compounds. Ion implantation, diffusion kinetics and dopants, and the metallurgy of annealing are being investigated. Also, despite the highly advanced state of the art in silicon technology, many basic physical properties of silicon need to be understood, particularly properties related to small geometries and radiation hardening. In addition, a deeper understanding is sought of the physics of semiconductor defects, deep-level centers, and surface passivation, and negative-affinity surfaces. Also of interest are carrier transport properties such as lifetime, ionization coefficients, and hot-electron and other nonequilibrium characteristics.

2. Electro-Optic/Laser Materials

Materials studies are conducted to further the understanding needed for the improvement of electro-optic and laser devices, including multicolor electroluminescent devices. The primary objective is to search for new or improved materials which will permit frequency-agile lasers; efficient, easily controllable integrated optical circuits; and low-loss, low-dispersion, radiation-hard optical fibers.

3. Magnetic Materials

Research in magnetic materials aims mainly at magnetic devices which will operate at frequencies well above 20 GHz into the near-millimeter range. For this reason, the predominant interest is in ferrites which exhibit high saturation, narrow resonant line widths, and low loss. Also being studied are high-energy-product, zero-temperature-coefficient permanent magnets for applications (such as in travelling wave tubes). In general, basic physical processes such as exchange interactions need to be understood.

4. Dielectric Materials

In the study of dielectric materials, three main thrusts can be discerned which clearly address problem areas in communication and signal processing. Surface-acoustic-wave technology requires a cost-effective material with a high coupling constant and zero temperature coefficient. For crystal oscillators, materials are sought which exhibit long-term stability under various environmental conditions. Also, novel materials are needed for use in dielectric near-millimeter waveguides. In addition, dielectric materials with low thermal impedance are required as mountings for a variety of high-power-density electronic devices.

5. Thermal Materials

This research area is directed at low cost uncooled thermal imaging devices. Materials with increased sensitivity to temperature changes are sought for pyroelectric retinas, thermo-optic (absorption shift) devices, or any other novel thermal imaging concepts.

6. Novel Batteries

The Army needs efficient, high-energy-density primary and secondary batteries. First priorities in this area are to understand the physical chemistry of lithium and lithium alloy anodes and of electrode processes involving oxyhalide, sulfide, and oxide reactants. Long storage shelf life is an important property for military systems.

7. Other Materials Requirements

Microfabrication of semiconductor devices requires an ability to synthesize and understand fast, high-sensitivity and high-contrast e-beam and x-ray lithographic materials. For advanced electron tube applications, high-current electron emitters are sought which exhibit extremely long operational lifetimes.

8. Microwave Through Near-Millimeter-Wave Components

The study of microwave through near-millimeter-wave components includes three highly active Army interests: large-scale circuit integration, including very-high-speed integrated circuits; high-power, frequency-agile, near-millimeter, solid-state oscillators; and ultrastable frequency control. This research activity covers device physics of submicrometer carrier transport and hot electron effects, such as are found in avalanche photodiodes, Gunn diodes, or IMPATT diodes, as well as in certain field-effect-transistor structures and Schottky barrier devices. The Army is also interested in superconducting devices. Other Army objectives include performance improvements in filters and phase shifters.

9. Near-Millimeter Wave Through Optical Sources

Coherent and incoherent sources for the visible, infrared, far-infrared, and submillimeter range are being investigated for illumination, identification, or communication. Among the specific research objectives are the understanding of the physics of laser transitions and the development of new pumping methods, efficient up-conversion techniques, sources with enhanced coherence and stability, and picosecond processors. Frequency selectivity and tunability of infrared emitters are very important.

10. Near-Millimeter Wave Through Optical Circuits and Systems

The Army is actively pursuing the goal of using optical-fiber and near-millimeter guided-wave communications. This goal requires thorough understanding and optimization of guided propagation and of control components such as phase shifters, tunable filters, and non-reciprocal devices. Low-loss coupling among active and passive components is essential. Also included here are integrated optics, adaptive optics, beam-steering techniques, acousto-optical interactions, and control of electromagnetic pulse interference.

11. Detectors and Displays

This is an important and very active area of Army interest which encompasses work on monolithic and hybrid intrinsic high density infrared detector arrays with integral CCD read out capability (high priority being given to HgCdTe structures), novel uncooled thermal imaging techniques, photocathodes and CCD imagers in 1-2 micron spectral region. Among the near millimeter wave through optical detector schemes, Schottky devices and Josephson and metal-oxide-metal junctions with associated circuitry are being studied. In the display field, much of the work is of developmental nature. However, some basic efforts are underway to understand the physics and to improve performance of luminescence, phosphorescence, liquid crystals, and light emitting diodes for use in low power, flat panel, high contrast multicolor displays.

12. Fabrication Technology and Reliability

A substantial effort is under way to understand where and why electronic devices or systems have failed. Effects due to radiation and other environmental parameters (such as shock) are analyzed, and methods for hardening are devised. Material-processing schemes which ultimately increase device reliability are needed. Examples are low-temperature processing of semiconductors and nonoptical lithography, as well as improved photolithographic techniques and processes.

B. Electromagnetics

1. Sources (Other Than Solid State)

The Army is currently investigating the potential of millimeter and submillimeter-waves for many of its new systems because of antenna size requirements and the desirable propagation characteristics of these wavelengths. A key to the successful implementation of most of these systems is the availability of convenient, reliable rf-power sources which for many applications may be some type of electron tube. The electron beam and individual components of the tube (such as the cathode, gun, grids, interaction structure, and collectors) must be investigated by modern analytical and synthesis techniques. New tube types such as those which employ fast-wave interaction and diffraction electron-beam devices should be investigated.

For higher frequency application (220 GHz and higher) novel source concepts which depend on E-O processes are being pursued. Examples are optically pumped molecular lasers, laser modulated traveling wave sources, and second harmonic generation.

2. Coupling

Coupling from multimode fiber optics in integrated optic structures remains a critical problem in optical communication systems. Current plans call for all data processing and multiplexing to be done outside the optical system. It appears that the solution to this interface problem will take one of two forms. Either a mode coupling device will be developed based upon mode coupling theory, such that coupling takes place over an extended region, or multi-mode integrated optics devices will be developed. Because of the hostile electromagnetic environment (due to our own transmissions, enemy jamming, or electromagnetic pulse from nuclear blasts) in which Army systems must operate, aperture coupling into devices and systems must receive increased attention.

3. Antennas

The Army needs antennas that are electrically small with minimal physical signatures, as well as highly survivable in the battlefield. Since electrically small antennas are strongly influenced by their surroundings, the electrical characteristics of small and conformal

antennas mounted near complex structures must be considered, including fundamental bandwidth limitations and efficiency trade-offs. Such antennas find application in vehicular, manpack, missile and fuze systems.

With the emphasis on millimeter and submillimeter wavelengths, the need increases for theoretical and experimental investigation into new approaches leading to low-cost, high-performance millimeter-wave antennas for communications, terminal guidance, and fuzing applications. Sidelobe suppression techniques will be applied to all antenna systems (including the radome) from vhf through millimeter wavelength.

Near-field measuring techniques will have to be refined so that systematic and statistical errors can be removed from the measured result, so that out-of-band response of antenna systems can be determined, and so that malfunctions and alignment error of large antenna systems can be determined.

4. Propagation

For highly reliable systems to be achieved, accurate propagation models of the battlefield must be available for VLF through UV frequencies. These would include propagation models for hilly terrain, built-up areas, vegetation, the ionosphere, and the troposphere. Problems associated with propagation through a battle area receiving heavy artillery fire (with scattered large diameter debris, particulates, smoke and heat plumes) must be considered.

In addition, fiber-optic transmission systems operating at longer wavelengths (5 to 10 μM) need to be considered to reduce losses and sensitivity to nuclear effects. New, easily fabricated, noncritical waveguiding techniques, in conjunction with active and passive components, need to be investigated for millimeter and submillimeter wavelengths. It is essential that the proposed techniques be able to use procedures similar to those employed in the manufacture of integrated circuits in order that manufacturing costs may be substantially reduced.

5. Diffraction and Scatter

To detect, classify, identify, and track targets, a thorough understanding of electromagnetic scatter and diffraction is essential. Problems arise when the targets are of wavelength size, are stationary, and/or are hiding in a clutter environment. Counter-measure techniques to

control the radar cross section of military vehicles must be considered.

C. Communications

1. Coding

In this area, the Army needs robust methods for signal coding which can be used for error detection and correction and for secure transmission of information. Also, coding techniques are needed that permit multiple signals and multiple access on the same channel, as well as adaptive control for optimizing the channel's use. Coding research to reduce susceptibility to interfering signals and ambiguity should be pursued. Importance is also placed on the identification of rate-distortion bounds for a variety of fidelity criteria and for signal compression.

2. Adaptive Communications and the Multisignal Environment

Research in adaptive communications and the multisignal environment may overlap the area of coding; however, approaches are not limited to coding. Novel approaches to providing covert, jam-resistant rf communications for an electronic warfare environment are important. Techniques such as spread-spectrum, novel detectors, adaptive antenna control, and adaptive multiplexing are important for combating electronic countermeasures and other interference, both natural and man-made.

3. Generalized Cost Criteria for Estimation, Detection, and Filtering

A large number of different approaches for designing systems with estimation, detection and filtering are available. The processes of defining specifications and comparing performance for these different approaches has become increasingly difficult. Generalized methods which can be applied in the evaluation of all approaches are needed so that the best designs can be identified.

4. Networks

In the future, communications networks in the Army will become all digital and increase in size and distribution. The task of maintenance and control grow proportionately in complexity. It is highly desirable to devise automatic systems (such as distributed

microprocessors) for multiplexing, interconnecting, switching, and control. It is extremely important to maintain data communication throughput during times of battle when the quantity of data transmitted increases and nodes and links may be lost. Consequently, research in routing strategy and automatic network management must receive increased attention.

5. Communications in Built-Up Areas (COBA)

Many major battles occur within built-up areas, such as large cities, where communication with standard radio sets is difficult. Some imagination and creativity must be used to devise techniques by which reliable communications can be established on the streets and within buildings in built-up areas. Suggestions have included use of ultraviolet light and acoustics.

D. Computers

1. Architecture

The modern Army depends for many of its operations on reliable and efficient computer systems. The Army maintains a continuing interest in achieving more efficient and reliable computer and communication equipment, organizations, and procedures. Computer architectures for efficient distributed processing, controls to improve memory-access techniques, and reliable digital transmission are expected to contribute materially to this Army area of interest. Examples are direct communications between machines (as in sensors to display consoles), data base computers, and data networks.

2. Software

The high cost of software magnifies the importance to the Army of methods for software cost reduction, for increasing the reliability of software, for more efficient software production, and for decreasing software maintenance costs. Improved methods for distributed and parallel processing are important. New approaches are needed in languages and procedures for improved software quality and in program testing and verification. Increased use of microprocessors demands simplified operating systems, simplified application-software production methods, and more flexible display software.

E. Signal Processing

1. Multi-Dimensional Processing

Many signals, such as images, are intrinsically two-dimensional (2-D). Most 2-D signals can be reduced to sets of one-dimensional (1-D) signals and processed with 1-D processing. However, 2-D processing of inherently 2-D signals should be the better approach. Much work has been done to extend 1-D techniques to 2-D; however, many concepts in 1-D are not readily extendible to 2-D. Research in this area should emphasize development of 2-D signal-processing theory, efficient representation for 2-D signals, efficient 2-D signal-processing algorithms, and nonlinear processing. Digital, optical, electro-optical and acousto-optical approaches are included. Applications include (1) target detection, recognition, cueing, and tracking, (2) composition of images from multiple sensors into a single image, (3) image correlation and change detection, (4) terminal guidance, and (5) automated topographic map generation.

2. Electro-Optical/Acousto-Optical Processing

Fiber-optic (FO) communications systems have many applications for Army systems; and FO cable technology is maturing rapidly. Technology for optical to electrical conversion (and vice versa) needs additional emphasis. Ideally, functions such as multiplexing, switching, and filtering are best performed optically to eliminate losses that would occur if optical-electrical-optical conversion is required. Increased speed and throughput as well as minimum size and weight are continually sought for signal processing. Tremendous gains that have been made in electronic digital processing still do not satisfy these performance demands. Electro-optical (EO) and acousto-optical (AO) approaches to transformation, correlation and 2-D processing demand strong research support. Optical approaches to fast-access, extremely high-density memories are of considerable importance.

3. Real-Time Processing

Real-time processing is the ultimate objective in nearly every Army signal-processing application. EO and AO processing are not expected to be able to satisfy all needs in this area. Rapid technological advance in digital electronics promises much improved capability. As in EO and AO processing, high speed, high accuracy,

and high throughput are sought for transformation, correlation, and filtering algorithms. Particular attention should be given to parallel and distributed approaches and to 2-D processing.

4. Digital Filtering

Digital filtering is a relatively mature field of research which does not justify significant emphasis, except in certain areas such as stability, infinite impulse-response recursive design, design for multiple complex performance criteria, nonlinear design criteria, and 2-D digital filters.

F. Integrated Circuits

1. Integrated Circuit Design

Significant advances are being made in the development of infrared devices, CCD's, surface-acoustic-wave devices, EO devices, and high-frequency rf devices. These advances need to be transitioned to integrated circuit (IC) technology. Also needed is high-quality research into ways to incorporate these and other appropriate devices into IC's, such as by integration of (1) signal-processing circuits on imaging focal planes, (2) IR detecting and processing circuits, (3) thin-film IC's, and (4) input/output circuits on-chip with the devices. Increased speed and accuracy must be emphasized for military systems. Also of significant importance are the LSI and VLSI circuits. Research is encouraged to develop designs for hardwired functions, transforms, analog to digital converters, and special-purpose processors with Army relevance. Automated design of IC's is of interest to the Army, and industry as a whole, for reducing design time and cost and producing higher quality design. Designs are often so complex that automation is the only reasonable approach to an efficient design process. Computer-aided IC design, layout, analysis, and simulation are important subjects for research including IC process modelling. Hybrid IC design is also important. The ultimate goal of this research should be to achieve a completely automated design process which produces a finished IC chip from a set of input/output specifications.

2. Novel Circuit Designs and Theory

Army applications often generate needs for circuit performance which are not of strong interest to the electronics industry

at large. The Army encourages research into broadband, high-frequency circuits (60 to 500 MHz) that are capable of fast tuning and high power amplification; such circuits include frequency synthesizers and voltage-controlled oscillators. Circuit theory for microwave circuits and devices is not complete and requires increased attention; phenomena exist that are not explained by theory. Opportunity exists for research to develop novel communications circuits for spread-spectrum communications and radar, multi-access/multi-user communications, noise cancellation, interference rejection, and integrable voltage references.

3. Fault-Tolerant Design

Most Army electronics systems perform critical functions, loss of which would endanger critical systems and human lives. Fault-tolerant design is a technique to ensure continued operation in the presence of failures. Research in radiation hardening and testing methods for failure-mode identification is important to improve device reliability. Research is needed into IC designs which incorporate built-in test and diagnosis or which include circuit designs which enhance external testing capability. Functional redundancy and system control and protocol must be included in research for fault-tolerant IC's.

RESEARCH INTERESTS AND POINTS OF CONTACT FOR DARCOM ORGANIZATIONS

Contained within the following section is a list of the U. S. Army Materiel Development and Readiness Command (DARCOM), Alexandria, VA elements with a significant research activity relating to electron devices and systems. An abbreviated mission statement along with the name of an individual who has been designated as the point of contact is included for each element.

The Center for Communications Sciences and the Center for Tactical Computer Systems are part of the U. S. Army Communications Research and Development Command (CORADCOM), Ft. Monmouth, NJ. The Electronics Technology and Devices Laboratory, Harry Diamond Laboratories and Night Vision and Electro-Optics Laboratories are part of the U. S. Army Electronics Research and Development Command (ERADCOM), Adelphi, MD, and White Sands Missile Range is part of the U. S. Army Test and Evaluation Command (TECOM), headquartered at Aberdeen Proving Ground, Maryland.

US ARMY RESEARCH OFFICE/ELECTRONICS DIVISION

MISSION. The electronics and communications sciences task of the Army Research Office contributes to the technology base through the exploration of novel phenomena and the generation of new concepts relevant to the Army's needs in electronics technology. The objective is to provide a science and technology base in selected areas of physics, electronics, communications and computer engineering to help satisfy present and future Army requirements. Research to obtain fundamental information is supported on a contractual basis at universities and non-profit as well as industrial laboratories in the areas of signal generation, transmission, reception and processing; computer systems and communication theory; solid state electronics to include semiconductors, superconductors, magnetics and dielectrics; circuitry and networks. In addition to the regular grants and contracts program, the Army Research Office also contributes to and shares in the management of the Joint Services Electronics Program (JSEP).

Point of contact:

Commander
US Army Research Office
Electronics Division (Dr. J. R. Suttle)
P. O. Box 12211
Research Triangle Park, NC 27709

CORADCOM-CENTER FOR COMMUNICATIONS SCIENCES

MISSION. CENCOMS is responsible for research and development related to communications systems and equipments. This encompasses R&D in the fields of cable, radio, telephonic and data communications, record communications (narrative and graphic), communications security, EMC and EMI, optical character recognition and communications/information processing. Research interests include propagation in the VLF through optical and UV wavelengths, antennas (including low-silhouette), all transmission media including extra-terrestrial, digital communications, fiber optic communications, spread spectrum communications, low probability of intercept communications, digital modulation concepts, error control coding, channel simulation and characterization, speech processing, digital switching technology, and data compression/source encoding.

Point of Contact:

Commander
US Army Communications Research and Development Command
ATTN: DRDCO-COM-RM (Mr. I. Kullback)
Fort Monmouth, NJ 07703

CORADCOM-CENTER FOR TACTICAL COMPUTER SCIENCES

MISSION. CENTACS mission is threefold. It conducts technology base research and development programs in tactical computer systems and sciences. Second, multi-application computer hardware and software systems are planned and developed. Third, CENTACS serves as a focal point for computer related engineering support for tactical computer based system developers. Research interests include computer architectures, high level languages, microprocessor-based systems, security in operating systems/computer networks, interoperability of hardware/software systems, automatic test equipment, built-in fault detection, isolation, and reporting, support of post-deployment software, display technologies, and communicative (tactical information retrieval and display) technology.

Point of contact:

Commander
US Army Communications Research and Development Command
Center for Tactical Computer Systems
ATTN: DRDCO-TCS-B (Mr. V. Alfieri)
Fort Monmouth, NJ 07703

ERADCOM-ELECTRONICS TECHNOLOGY AND DEVICES LABORATORY

MISSION. Develop an essential base in electronics technology and devices consistent with next generation Army system operational requirements. Associated critical barrier device problems are pursued through a broad-based internal and contractual program in the specific areas of micro-electronics (semiconductor, LSI and hybrid devices; the Laboratory maintains the Army's principal integrated circuit facility), display devices, microwave devices, power sources, frequency control and filter devices, electron tubes, high power subsystems, and electronic materials.

Point of contact:

Commander
U. S. Army Electronics Technology
& Devices Lab
ATTN: DELET-E (Dr. J. A. Kohn)
Fort Monmouth, NJ 07703

ERADCOM-HARRY DIAMOND LABORATORIES

MISSION. Electronically related mission areas of the Harry Diamond Laboratories (HDL) include the responsibility for materiel RDT&E and initial procurement in support of the ERADCOM mission to locate and identify enemy forces through the use of radar technology and other electronic devices, and to neutralize or destroy the enemy with electronic weaponry, devices, and fuzes. HDL is responsible for RDT&E, product improvement, design integrity, and currency of the technical data package for electronic fuzes together with their setters, test equipment, simulators, telemeters, and control equipment. HDL is active in the developments of special radar systems, and is responsible for enhancing the capability of materiel to operate in a nuclear weapons environment by providing effects data, system and component vulnerability information, and hardening technology to developers. HDL develops ECCM techniques for electronic fuzes and radars.

Point of contact:

Commander
Harry Diamond Laboratories
ATTN: DELHD-CM (Mr. H. Gibson)
2800 Powder Mill Rd.
Adelphi, MD 20783

US ARMY MISSILE RESEARCH AND DEVELOPMENT COMMAND

MISSION. To plan, manage and conduct research, exploratory and advanced development for guided missile and rocket weapon systems and related components, devices and techniques. Perform development engineering for missile systems and perform selective research and component development to generate new technology, reduce missile development lead time, and improve reliability. Operate Army Inertial Guidance Management and Technology Center and Army Rocket Propulsion Technology and Management Center. Serves as DARCOM Lead Laboratory for Guidance and Control/ Terminal Homing. Plan and direct development of test equipment for system instrumentation and test requirements.

Point of contact:

Commander
US Army Missile Research and Development Command
ATTN: DRDMI-TE (Mr. W. Pittman)
Redstone Arsenal, Alabama 35809

ERADCOM-NIGHT VISION AND ELECTRO-OPTICS LABORATORY

MISSION. The Night Vision and Electro-Optics Laboratory is responsible for materiel acquisition to support the operational mission of locating and identifying high value enemy targets, using any required sensor technology. The Laboratory's programs are centered around two principal areas: image intensification and far infrared (thermal imaging). In addition, the Laboratory develops low-energy lasers for range-finding and target designation. In the performance of this mission, the Laboratory is currently pursuing the following key technologies: uncooled infrared focal planes (HgCdTe), 1-2 micron photocathodes and CCD's, flat panel displays, near millimeter wave sources and detectors, CO₂ lasers, and image processing for smart sensors.

Point of contact:

Mr. John Johnson
Deputy Director
Night Vision & Electro-Optics Lab
ATTN: DELNV-D
Fort Belvoir, VA 22060

TECOM-US ARMY WHITE SANDS MISSILE RANGE

MISSION. Provide the Instrumentation Systems, equipment and facilities which comprise the National Range drone, rocket, and space vehicle flight test facility. Conduct the planning, research, development, and engineering to maintain the range instrumentation capabilities consistent with current and future needs. Conducts the technology-base (research, exploratory development, nonsystem advanced development) program supporting instrumentation development by the directorate. Program includes research (basic and applied) into various aspects of data collection, transmission and processing; system/component design, test and evaluation; conceptualization and development of innovative applications of existing and emerging technologies; analytical and experimental examination of technology applications, to establish feasibility and areas of risk; prototype development, to establish performance limits and procurement specifications; and transfer of verified technologies.

Point of contact:

Commander
US Army White Sands Missile Range
ATTN: STEWS-ID-T (Dr. A. L. Gilbert)
White Sands Missile Range, NM 88002